WE CLAIM:

1. A cooling tube for cooling an object, comprising:

a first end of the cooling tube in fluid communication with a second end,

wherein the cooling tube has bends along its length between the first and second ends and no plane exists where the first end, second end, and a centerline of cooling tube project onto a straight line in a plane.

2. The cooling tube described in Claim 1, wherein the bends allow the cooling tube to expand and contract in response to temperature gradients.

3. The cooling tube described in Claim 1, wherein the cooling tube is fabricated from a metallic material.

4. The cooling tube described in Claim 1, wherein the cooling tube is fabricated from a material that is a ceramic matrix composite material.

5. The cooling tube described in Claim 3, wherein the ceramic matrix composite material has a woven tubular shape.

6. The cooling tube described in Claim 1, wherein the cooling tube has dents to disrupt laminar flow of cooling air flowing through the cooling tube and to provide additional stress relief.

7. The cooling tube described in Claim 1, wherein the cooling tube has bulges to disrupt laminar flow of cooling air flowing through the cooling tube and to provide additional stress relief.

8. A cooling tube for cooling a liner of a combustor chamber of a gas turbine engine, comprising:

the cooling tube having a first end in fluid communication with a plenum supplying air to the combustor chamber;

and a second end in fluid communication with an area in proximity with a gas injector comprising the gas turbine engine,

wherein the cooling tube has a serpentine shape conforming to a contour of the liner and the serpentine shape of the cooling tube allows the cooling tube to expand and contract in response to temperature gradients in the combustor chamber.

9. The cooling tube described in Claim 8, wherein the cooling tube is positioned within the combustor chamber along an interior side of the liner

10. The cooling tube described in Claim 8, wherein the cooling tube is positioned outside the combustor chamber along an exterior side of the liner

11. A cooling tube assembly for cooling a liner of a combustor chamber of a gas turbine engine, the assembly comprising

a plurality of serpentine cooling tubes attached to the liner, each serpentine cooling tube conforming to a contour of the liner,

wherein each serpentine cooling tube has a first end in fluid communication with a plenum supplying air to the combustor chamber and a second end in fluid communication with an area in proximity with a gas injector comprising the gas turbine engine.

12. The cooling tube assembly described in Claim 11, wherein the cooling tube assembly is in contact with the liner.

13. The cooling tube assembly described in Claim 11, wherein the cooling tube assembly is maintained a spaced distance from the liner.

14. The cooling tube assembly described in Claim 13, wherein:

each cooling tube is supported by a plurality of pins to maintain the cooling tube the spaced distance from the liner, and

each pin has a proximal end attached to the cooling tube and a distal end inserted through a hole in the liner, the distal end being secured from removal from the hole in a manner allowing rotational movement of the pin within the hole.

15. The cooling tube assembly described in Claim 14, wherein:

each cooling tube is fabricated of a metallic material; and

each proximal end is secured to the cooling tube by brazing.

16. The cooling tube assembly described in Claim 11, wherein the plurality of cooling tubes is positioned on an exterior side of the liner.

17. The cooling tube assembly described in Claim 11, wherein the plurality of cooling tubes is positioned on an interior side of the liner.

18. The cooling tube assembly described in Claim 11, wherein the serpentine shape of each tube is formed as a plurality of alternating convex and concave bends along a length of each tube.

19. A method of fabricating a cooling tube, comprising:

providing a woven tubular shape formed of ceramic matrix composite fabric;

providing a mandrel comprised of expendable material;

inserting the mandrel into the woven tubular shape;

densifying the CMC fabric; and

removing the expendable material.

20. The method described in Claim 19, wherein the step of removing the expendable material is accomplished by heat vaporization.

21. The method described in Claim 19, wherein the step of removing the expendable material is accomplished by oxidation.

22. The method described in Claim 19, wherein the step of removing the expendable material is accomplished by chemical means.

23. The method described in Claim 19, wherein the mandrel conforms to the configuration of a combustor liner.

24. The method described in Claim 19, wherein the mandrel has a serpentine shape.

25. A method of cooling a combustor liner, comprising:

diverting a portion of an incoming pressurized gas stream entering an intake end of the combustor to a plenum located proximate an exhaust end of the combustor;

directing the pressurized gas stream from the plenum through a plurality of serpentine cooling tubes aligned along a surface of the combustor liner, each serpentine cooling tube having a first end in fluid communication with the plenum and a second end in fluid communication with an area proximate with a fuel atomizer;

allowing the pressurized gas stream flowing through the serpentine cooling tubes to absorb heat from the combustor wall to heat the pressurized gas stream to form a heated gas stream; and

providing the heated gas stream exiting the second ends to the fuel atomizer, whereby the heated gas stream aids combustion.

26. The method of cooling a combustor liner described in Claim 25, wherein the plurality of serpentine cooling tubes is aligned along an interior surface of the combustor liner.

27. The method of cooling a combustor liner described in Claim 25, wherein the plurality of serpentine cooling tubes is aligned along an exterior surface of the combustor liner.

28. The method of cooling a combustor liner described in Claim 27, wherein the plurality of serpentine cooling tubes is comprised of a ceramic matrix composite material.

29. The method of cooling a combustor liner described in Claim 26,

wherein the plurality of serpentine cooling tubes is comprised of a metallic material, and

wherein each cooling tube is supported by a plurality of pins maintaining the cooling tube a spaced distance from the liner, each pin having a proximal end attached to the cooling tube and a distal end inserted through a hole in the liner, the distal end being secured from removal from the hole in a manner allowing rotational movement of the pin within the hole.